THEREFORE WHAT IS CLAIMED IS:

1. A photonic crystal having a tunable photonic band structure, comprising;

a periodic composite dielectric material having at least two dielectric constituents including a first dielectric constituent having a first refractive index and a second dielectric constituent having a refractive index smaller than the first refractive index so that the periodic composite dielectric material has a photonic band structure; and

at least one of said at least two dielectric constituents having refractive index properties which can be locally or globally changed throughout said photonic crystal in a controlled manner whereby changing the refractive index properties modulates said photonic band structure locally or globally throughout said photonic crystal.

2. The photonic crystal according to claim 1 wherein said periodic composite dielectric material includes periodic void regions throughout a volume of said periodic composite dielectric material.

3. The photonic crystal according to claim 2 wherein said periodic composite dielectric material is an inverted opal wherein said void regions are overlapping air spheres formed in a face centered cubic lattice.

4. The photonic crystal according to claim 1 wherein said periodic composite dielectric structure includes a complete photonic bandgap which is tunable.

5. The photonic crystal according to claim 2 wherein said periodic composite dielectric structure includes a complete photonic bandgap which is tunable.

6. The photonic crystal according to claim 3 wherein said periodic composite dielectric structure includes a complete photonic bandgap which is tunable.

7. The photonic crystal according to claim 1 wherein said first dielectric constituent is a semiconductor.

8. The photonic crystal according to claim 2 wherein said first dielectric constituent is a semiconductor.

9. The photonic crystal according to claim 3 wherein said first dielectric constituent is a semiconductor.

10. The photonic crystal according to claim 6 wherein said first dielectric constituent is a semiconductor.

11. The photonic crystal according to claim 2 wherein said at least one of the at least two dielectric constituents having refractive index properties which can be globally or locally changed includes a dielectric constituent having optical anisotropy infiltrated into said void regions, and wherein said optical anisotropy is controlled by application of one of an electric, magnetic and electromagnetic field.

12. The photonic crystal according to claim 3 wherein said at least one of the at least two dielectric constituents having refractive index properties which can be globally or locally changed includes a dielectric constituent having optical anisotropy infiltrated into said void regions, and wherein said optical anisotropy is controlled by application of one of an electric, magnetic and electromagnetic field.

13. The photonic crystal according to claim 6 wherein said at least one of the at least two dielectric constituents having refractive index properties which can be globally or locally changed includes a dielectric constituent having optical anisotropy infiltrated into said void regions, and wherein said optical anisotropy is controlled by application of one of an electric, magnetic and electromagnetic field.

14. The photonic crystal according to claim 10 wherein said at least one of the at least two dielectric constituents having refractive index properties which can be globally or locally changed includes a dielectric constituent having optical anisotropy infiltrated into said void regions, and wherein said optical anisotropy is controlled by application of one of an electric, magnetic and electromagnetic field.

15. The photonic crystal according to claim 12 wherein said dielectric constituent having optical anisotropy infiltrated into said void regions is selected from the group consisting of optically anisotropic compounds, ferroelectric materials exhibiting optical birefringence, and materials exhibiting Faraday-activity.

16. The photonic crystal according to claim 13 wherein said dielectric constituent having optical anisotropy infiltrated into said void regions is selected from the group consisting of optically anisotropic compounds, ferroelectric materials exhibiting optical birefringence, and materials exhibiting Faraday-activity.

17. The photonic crystal according to claim 14 wherein said dielectric constituent having optical anisotropy infiltrated into said void regions is selected from the group consisting of optically anisotropic compounds, ferroelectric materials exhibiting optical birefringence, and materials exhibiting Faraday-activity.

18. The photonic crystal according to claim 17 wherein said optically anisotropic compounds are selected from the group consisting of nematic liquid crystals and chiral molecules including cholesteric liquid crystals.

19. The photonic crystal according to claim 16 wherein said optically anisotropic compounds are selected from the group consisting of nematic liquid crystals and chiral molecules including cholesteric liquid crystals.

20. The photonic crystal according to claim 15 wherein said optically anisotropic compounds are selected from the group consisting of nematic liquid crystals and chiral molecules including cholesteric liquid crystals.

21. The photonic crystal according to claim 17 wherein said optically anisotropic compounds is a nematic liquid crystal, and wherein said band structure is modulated either globally or locally by rotations of a nematic director field of the nematic liquid crystal by application of an external electric field.

22. The photonic crystal according to claim 18 wherein said optically anisotropic compounds is a nematic liquid crystal, and wherein said band structure is modulated either globally or locally by rotations of a nematic director field of the nematic liquid crystal by application of an external electric field.

23. The photonic crystal according to claim 19 wherein said optically anisotropic compounds is a nematic liquid crystal, and wherein said band structure is modulated either globally or locally by rotations of a nematic director field of the nematic liquid crystal by application of an external electric field.

24. The photonic crystal according to claim 20 wherein said optically anisotropic compounds is a nematic liquid crystal, and wherein said band structure is modulated either globally or locally by rotations of a nematic director field of the nematic liquid crystal by application of an external electric field.

25. The photonic crystal according to claim 21 wherein said nematic liquid crystal is bis ethylhexyladipate (BEHA).

26. The photonic crystal according to claim 22 wherein said nematic liquid crystal is bis ethylhexyladipate (BEHA).

27. The photonic crystal according to claim 23 wherein said nematic liquid crystal is bis ethylhexyladipate (BEHA).

28. The photonic crystal according to claim 24 wherein said nematic liquid crystal is bis ethylhexyladipate (BEHA).

29. The photonic crystal according to claim 26 wherein said semiconductor is silicon.

30. The photonic crystal according to claim 29 wherein the periodic composite dielectric material has a lattice periodicity ranging from about 0.28 microns to about 1.8 microns.

31. The photonic crystal according to claim 17 wherein the periodic composite dielectric material has a lattice periodicity ranging from about 0.28 microns to about 1.8 microns.

32. The photonic crystal according to claim 31 wherein said void regions are infiltrated either partially or fully with said optically anisotropic compound.

33. The photonic crystal according to claim 30 wherein said void regions are infiltrated either partially or fully with said bis ethylhexyladipate (BEHA).

34. The photonic crystal according to claim 23 wherein said void regions are infiltrated either partially or fully with an optically anisotropic compound.

35. The photonic crystal according to claim 17 wherein said at least one of said at least two dielectric constituents having refractive index properties which can be globally or locally changed includes said semiconductor having implanted therein with a sufficient concentration of magnetic ions to exhibit Faraday-activity, and wherein said refractive index properties are changed by application of a magnetic field.

36. The photonic crystal according to claim 17 wherein said semiconductor is selected from the group consisting of Si, Ge, SiC, AlP, AlS, AsSb, GaP, GaAs, GaSb, InP, InAs, InSb, ZnO, ZnSe, CdSe and HgS.

37. The photonic crystal according to claim 22 wherein said semiconductor is selected from the group consisting of Si, Ge, SiC, AlP, AlS, AsSb, GaP, GaAs, GaSb, InP, InAs, InSb, ZnO, ZnSe, CdSe and HgS.

38. A photonic crystal having a tunable photonic band structure, comprising;

a periodic composite dielectric material having a first dielectric constituent having a first refractive index and void regions located periodically throughout a volume of said periodic composite dielectric material, a second dielectric constituent located in said void regions having a second refractive index sufficiently smaller than the first refractive index so that the periodic composite dielectric material has a photonic band structure; and

at least one of said first and second dielectric constituents being optically anisotropic and having refractive index properties which can be locally or globally modified in a controlled manner whereby changing the refractive index properties changes said photonic band structure.

39. The photonic crystal according to claim 38 wherein said first dielectric constituent is optically anisotropic and the refractive index properties of said first dielectric constituent can be changed, and wherein said second dielectric constituent is air.

40. The photonic crystal according to claim 39 wherein said first dielectric constituent is a semiconductor.

41. The photonic crystal according to claim 40 wherein said periodic composite dielectric material has at least one complete photonic band gap which is tunable.

42. The photonic crystal according to claim 41 wherein said second dielectric constituent includes at least one optically anisotropic material infiltrated into said void regions, and wherein it is the refractive index properties of said anisotropic material which can be changed in a controlled manner.

43. The photonic crystal according to claim 42 wherein said void regions are partially filled with said optically anisotropic material.

44. The photonic crystal according to claim 43 wherein said void regions are completely filled with said optically anisotropic material.

45. The photonic crystal according to claim 39 wherein the refractive index properties of the constituent having optical anisotropy is controlled by application of one of an electric, magnetic and electromagnetic field.

46. The photonic crystal according to claim 41 wherein the refractive index properties of the constituent having optical anisotropy is controlled by application of one of an electric, magnetic and electromagnetic field.

47. The photonic crystal according to claim 42 wherein the refractive index properties of said constituent having optical anisotropy is controlled by application of one of an electric, magnetic and electromagnetic field.

48. The photonic crystal according to claim 47 wherein the periodic composite dielectric material has a lattice periodicity ranging from about 0.28 microns to about 1.8 microns.

49. The photonic crystal according to claim 41 wherein the periodic composite dielectric material has a lattice periodicity ranging from about 0.28 microns to about 1.8 microns.

50. The photonic crystal according to claim 40 wherein the periodic composite dielectric material has a lattice periodicity ranging from about 0.28 microns to about 1.8 microns.

51. The photonic crystal according to claim 50 wherein said periodic composite dielectric material has at least one complete photonic band gap which is tunable.

52. The photonic crystal according to claim 38 wherein said first dielectric constituent is a semiconductor is selected from the group consisting of Si, Ge, SiC, AlP, AlS, AsSb, GaP, GaAs, GaSb, InP, InAs, InSb, ZnO, ZnSe, CdSe and HgS, and wherein said periodic composite dielectric material has at least one complete photonic band gap which is tunable.

53. The photonic crystal according to claim 42 wherein said semiconductor is selected from the group consisting of Si, Ge, SiC, AlP, AlS, AsSb, GaP, GaAs, GaSb, InP, InAs, InSb, ZnO, ZnSe, CdSe and HgS.

54. The photonic crystal according to claim 51 wherein said semiconductor is selected from the group consisting of Si, Ge, SiC, AlP, AlS, AsSb, GaP, GaAs, GaSb, InP, InAs, InSb, ZnO, ZnSe, CdSe and HgS.

55. The photonic crystal according to claim 42 wherein said semiconductor is silicon and said periodic composite dielectric material is an inverse silicon opal, and wherein said void regions are overlapping air spheres formed in a face centered cubic lattice.

56. The photonic crystal according to claim 55 wherein said complete photonic bandgap is centered on a wavelength of about 1.5 microns.

57. The photonic crystal according to claim 56 wherein said optically anisotropic material infiltrated into said void regions is selected from the group consisting of optically anisotropic molecules, ferroelectric materials exhibiting optical birefringence, and materials exhibiting Faraday-activity.

58. The photonic crystal according to claim 49 wherein said optically anisotropic material infiltrated into said void regions is selected from the group consisting of optically anisotropic molecules, ferroelectric materials exhibiting optical birefringence, and materials exhibiting Faraday-activity.

59. The photonic crystal according to claim 57 wherein said optically anisotropic molecules are selected from the group consisting of nematic liquid crystals and chiral molecules including cholesteric liquid crystals.

60. The photonic crystal according to claim 57 wherein said optically anisotropic molecules is a nematic liquid crystal, and wherein said band structure is modulated either globally or locally by rotations of a nematic director field of the nematic liquid crystal by application of an external electric field globally to the entire photonic crystal or locally to preselected portions of said photonic crystal.

61. The photonic crystal according to claim 40 wherein said periodic composite material has a structure selected from the group consisting of woodpile structures, inverse diamond structures, Yablonovite structures, spiral pillars and two dimensional periodic structures.

62. A method of tuning a photonic band structure in a photonic crystal, comprising;

providing a photonic crystal having a periodic composite dielectric material including a first dielectric constituent having a first refractive index, and at least a second dielectric constituent having an second refractive index constant sufficiently smaller than the first refractive index so that the periodic composite dielectric material has a photonic band structure; and

globally or locally changing the refractive index properties of one of said first and second dielectric constituents in a controlled manner so that said photonic band structure is changed in a controlled manner by application of one of an electric, magnetic and electromagnetic field.

63. The method according to claim 62 wherein said periodic composite dielectric material has periodic void regions throughout a volume of said periodic composite dielectric material, and wherein said periodic composite dielectric material has an inverse opal structure, and wherein said void regions are overlapping air spheres formed in a face centered cubic lattice, wherein said second dielectric constituent includes at least one optically anisotropic material infiltrated into said void regions, and wherein it is the refractive index properties of said anisotropic material which can be changed in a controlled manner.

64. The method according to claim 62 wherein said first dielectric constituent is optically anisotropic and the refractive index properties of said first dielectric constituent can be changed, wherein said periodic composite dielectric material has periodic void regions throughout a volume of said periodic composite dielectric material, and wherein said periodic composite dielectric material has an inverse opal structure, and wherein said void regions are overlapping air spheres formed in a face centered cubic lattice, and wherein said second dielectric constituent is air.

65. The method according to claim 64 wherein said first dielectric constituent includes a semiconductor.

66. The photonic crystal according to claim 63 wherein said optically anisotropic material infiltrated into said void regions is selected from the group consisting of optically anisotropic molecules, ferroelectric materials exhibiting optical birefringence, and materials exhibiting Faraday-activity.

67. The photonic crystal according to claim 66 wherein said optically anisotropic molecules are selected from the group consisting of nematic liquid crystals and chiral molecules including cholesteric liquid crystals.

68. The photonic crystal according to claim 67 wherein said optically anisotropic molecules is a nematic liquid crystal, and wherein said band structure is modulated either globally or locally by rotations of a nematic director field of the nematic liquid crystal by application of an external electric field

globally to the entire photonic crystal or locally to preselected portions of said photonic crystal.

69. The method according to claim 62 wherein said first dielectric constituent is optically anisotropic and the refractive index properties of said first dielectric constituent can be changed, wherein said second dielectric constituent is a dielectric solid dielectric material.